Space Weather Technical Forecast

Issued on Saturday, 13 January 2024 at 00:54 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity continues at Moderate levels. The largest flare of the period was an M1 peaking at 12/0258UTC from near AR3547 in the northeast. There is a HMI imagery outage as of 12/1045UTC. GONG intensitygram and magnetogram has been used to assess sunspot regions instead, however the lower resolution and limb effects mean that it is very difficult to discern minor changes to the sunspots. No significant changes are thought to have occurred in recent hours, however. There are around eleven sunspot regions on the disc, well distributed across different areas. Whilst none appear to be significantly complex, some uncertainty persists due to the lack of high resolution imagery.
There were no CMEs seen in the last 24 hours which were likely to have an Earth directed component.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by DSCOVR at L1, showed a slightly elevated character that has been ongoing for the last few days. The cause of this slight enhancement is not immediately clear, but in addition the solar wind speed was showing a very different tendency between ACE and DSCOVR. However, ACE has not been tracking for the last 24 hours so a comparison can't be made at present. Using DSCOVR, wind speeds varied between 450-480 km/s, with average density. The interplanetary magnetic field has been weak throughout at 5nT or below, with the north-south component varying weakly. Phi angle has also been variable. Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux was at background levels.
GOES16 high energy (greater than 2MeV) electron flux was at background levels. The associated 24-hour fluence was well below Active (1e8 integrated pfu) throughout. The 13/0000 UTC 24-hour integrated fluence observation was 2.27e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a chance of further M-class activity and a slight chance of X-class, declining slightly with the departure of AR3539.

Solar Wind / Geomagnetic Activity: There is one possible Earth directed CME in the forecast, which may give a glancing blow at Earth during Day 1 (13 Jan), although confidence is low. The next feature of interest is CH92/+ just approaching centre disc in the northern hemisphere. Wind speeds of 450-500 km/s, with an arrival time later Day 4 (16 Jan) or perhaps into Day 5, beyond the end of this forecast period, are most likely.
Overall, geomagnetic activity is likely to be Quiet throughout, but with a risk of Unsettled to Active intervals on Days 1 and 4 should we see any CME or HSS influence.

Energetic Particles / Solar Radiation: High energy proton flux will most likely remain at

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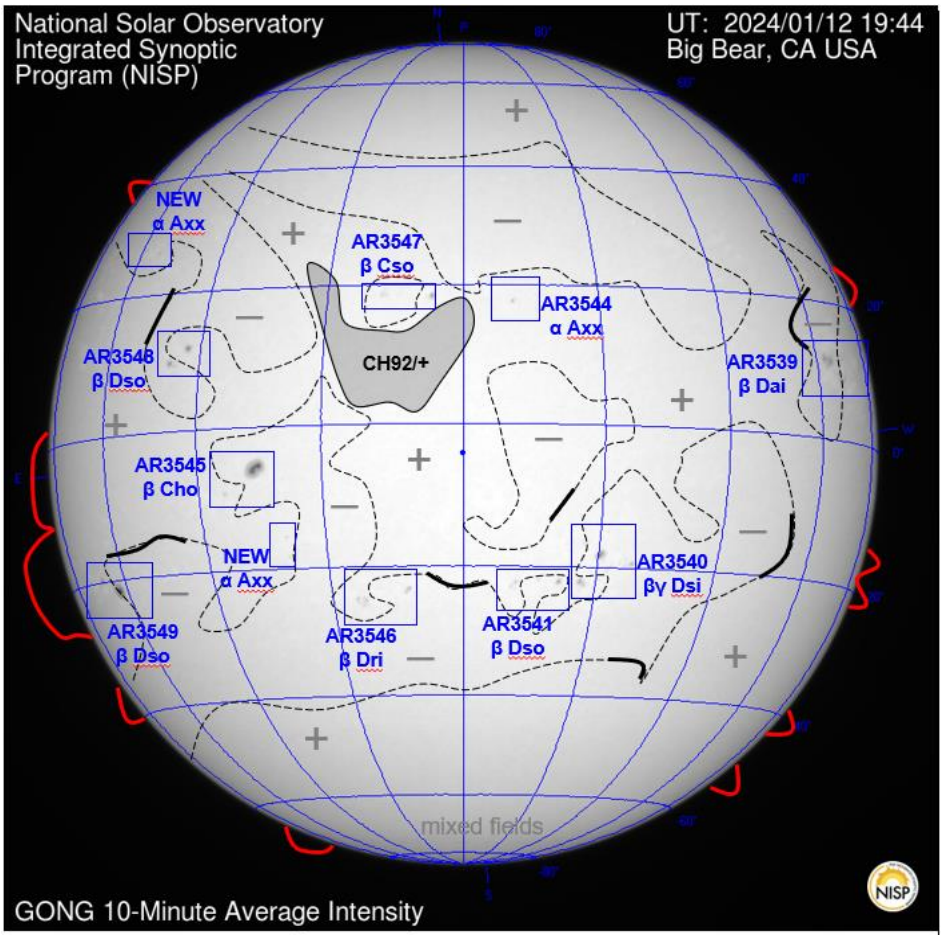
background levels through the period, but with an ongoing slight chance of seeing an increase to the S1/Minor Radiation Storm threshold, should any larger flares occur.
The high energy electron flux is forecast to persist at background levels, with fluence below Active through this period.

Figure 1. Solar Analysis Valid 12/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is one possible Earth directed CME in the forecast, which originated on 09 Jan from a southeastern filament eruption. This may give a glancing blow at Earth during Day 1 (13 Jan), although confidence is low. If it does reach Earth, due to the often greater density in filament eruptions, there is a slight chance of reaching G1/Minor Storm levels.

The next feature of interest is CH92/+ just approaching centre disc in the northern hemisphere. This is a persistent feature, but is much smaller than on the previous rotation, with the leading edge further back than last time around. Wind speeds in the High Speed Stream (HSS) reached above 600 km/s on the previous rotation, on the equivalent of Day 3 (15 Jan). However, the much reduced size of the coronal hole suggests wind speeds of 450-500 km/s are more likely this time, which combined with the change in location, gives a potential arrival time later Day 4 (16 Jan) or perhaps into Day 5, beyond the end of this forecast period.

Overall, geomagnetic activity is likely to be Quiet throughout, but with a risk of Unsettled to Active intervals on Days 1 and 4 should we see any CME or HSS influence.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	1	1	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
09/2240	Partial	Filament	SE	530 km/s	Crosses 1AU during 13 Jan, most likely miss	Any arrival likely to be weak

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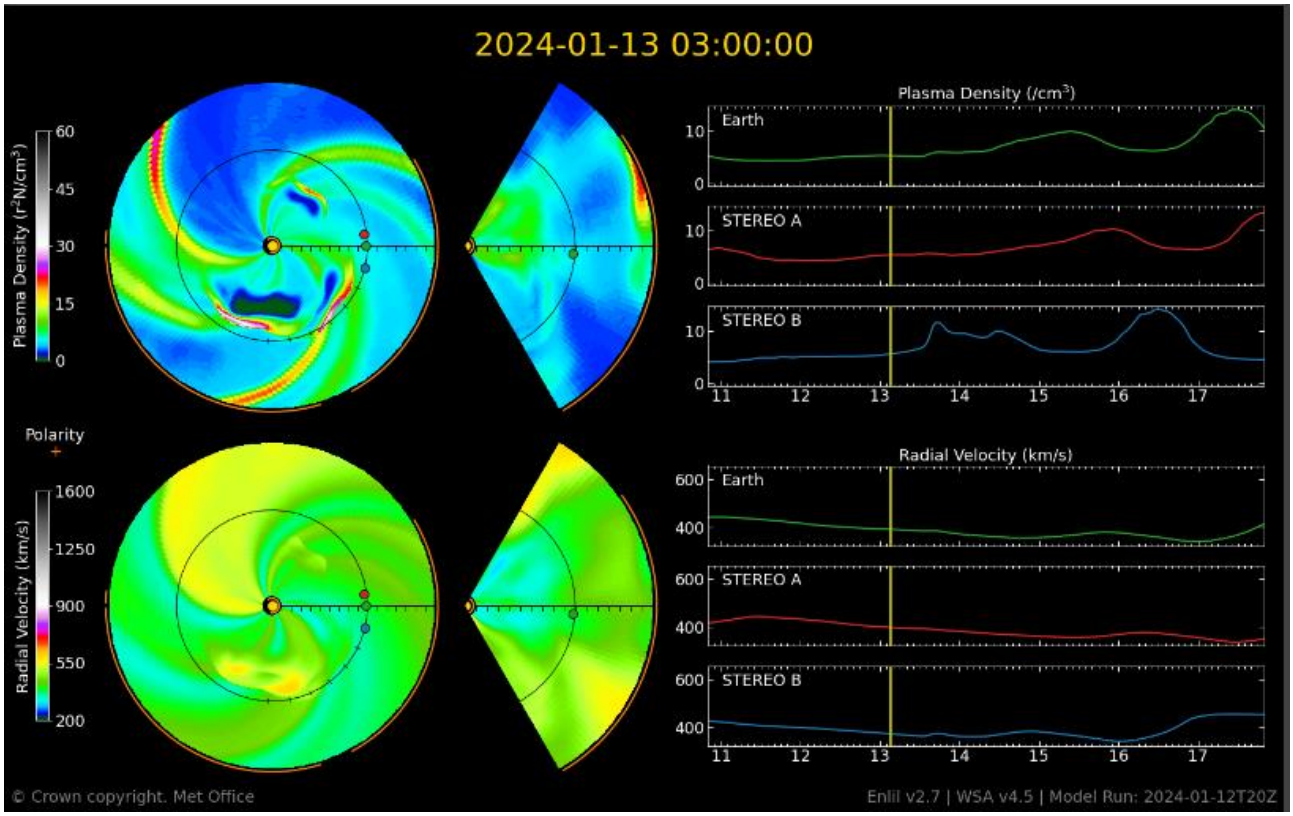
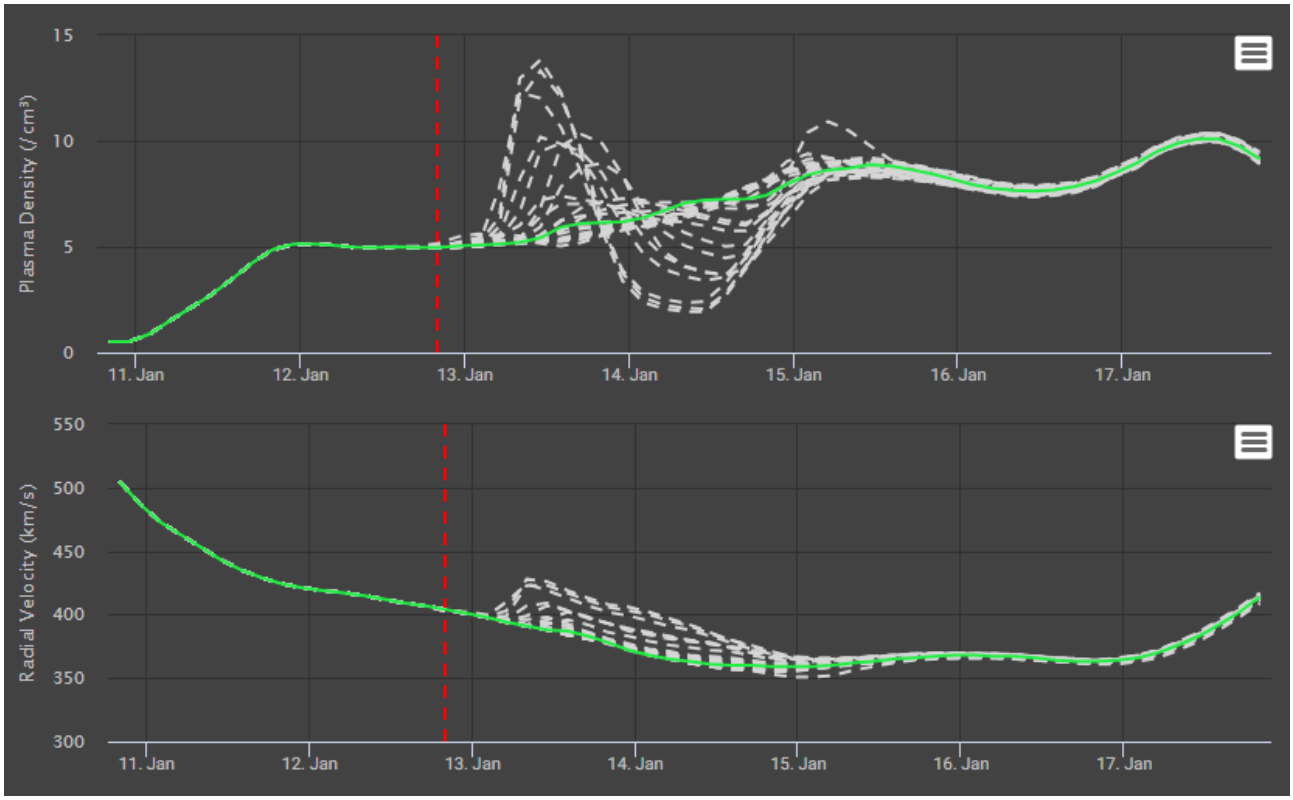
Figure 2: MOSWOC Enlil and ensemble, showing a potential CME arrival during 13 January. Enlil does not appear to have captured the HSS from CH92/+, with an increase likely during 16-17 January.





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Radio Blackouts - X-Ray Flares:
Solar activity continues at Moderate levels. The largest flare of the period was an M1 peaking at 12/0258UTC from near AR3547 in the northeast. There is a HMI imagery outage as of 12/1045UTC. GONG intensitygram and magnetogram has been used to assess sunspot regions instead, however the lower resolution and limb effects mean that it is very difficult to discern minor changes to the sunspots. No significant changes are thought to have occurred in recent hours, however. There are around eleven sunspot regions on the disc, well distributed across different areas. Whilst none appear to be significantly complex, some uncertainty persists due to the lack of high resolution imagery. The risk of further M-flares is well-spread across the facing side, with the possibility of further regions to rotate on from the far side, with returning Carringtons, far-side soundings and EUV east limb flux all suggesting the possibility of regions just over the limb.

There is a chance of further isolated M-flares, with a slight chance of X-flares. AR3539 is due to rotate off late on Day 2 (14 Jan), with a slight reduction in probabilities at this point. Any reinforcement from the east limb will be factored in as and when regions present for analysis.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	45	45
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: X-ray trace from GOES16 and 18 over the last 24 hours.

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Solar Radiation Storms - (High Energy Protons):
GOES18 high energy (greater than 10MeV) proton flux is now at background levels. Any further notable flares will bring a risk of proton flux rising, especially if they occur near the western limb. Overall, there is a continuing slight chance of reaching the S1/Minor Radiation Storm threshold. Please note: GOES18 is currently being used as the primary proton instrument, with GOES16 data currently viewed as unreliable due to a fault reported by NOAA.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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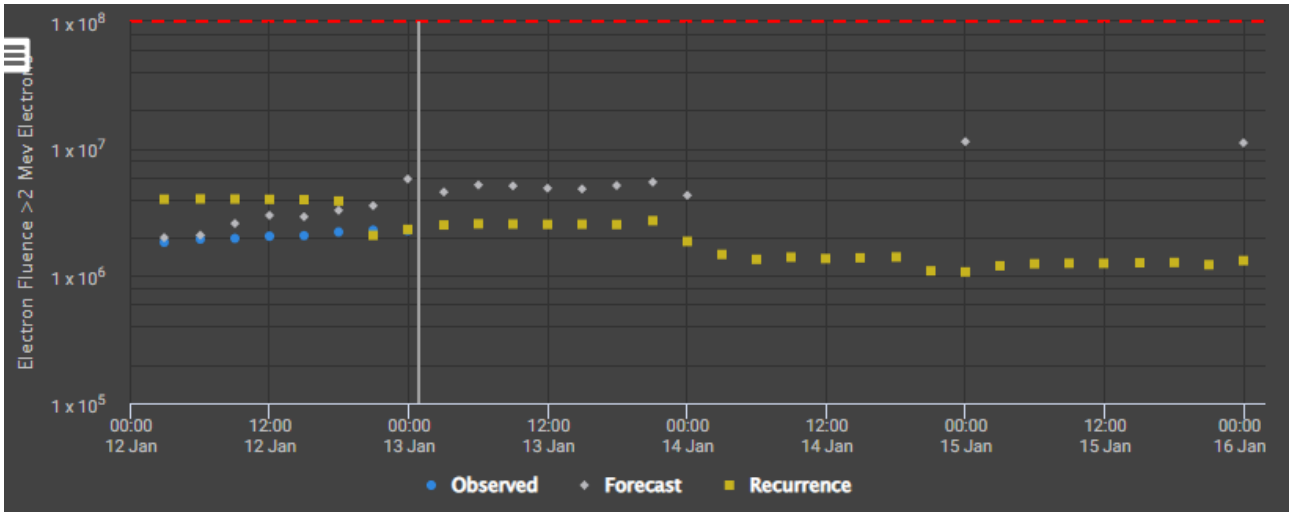
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) as measured by GOES16 at GEO is currently at background levels, and in the absence of any significant enhancement is expected to persist at this level throughout the four days. Any CME arrival on Day 1 (13 Jan) and HSS on Day 4 (16 Jan) are both likely to be weak features, with any significant increase in electron flux due to these features considered unlikely. There is just a slight chance of minor geomagnetic storms should we see a stronger blow from the CME which could give some flux increase, but the risk of this is considered very low at present. The associated 24-hour fluence is therefore expected to remain below the Active threshold.

MOSWOC REFM output maintains fluence well below Active throughout the next 72 hours. Even with possible glancing incidence of the 09 January CME slightly complicating matters, the most likely forecast remains a miss and REFM is likely to be accurate.

GEO Electron Environment	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	1
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: MOSWOC REFM forecasting well below Active for the next few days, which seems like good guidance.



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